CHAPTER 6: DESIGNING EXPERIMENTS

Section 6.1:

Experiment vs. Observational Study (again!)

* Experiment = treatment applied to all subjects

* Obs. Study = no treatment imposed, just observe subjects and record data

Explanatory Variable-

* A variable that we think explains or causes changes in the response variable

Response Variable-

* A variable that measures an outcome or result of a study

Individuals- the things that experiment is being performed on (cars, plants, etc.)

Subjects- people in an experiment

Treatment-

* A specific condition applied to all individuals in an experiment

Example 1: A scientist wants to see if a new fertilizer will help the growth of rose bushes. He wants to compare this to the current fertilizer as well as no fertilizer at all. He has 20 rose bush plants to use.

Subjects/Individuals:

Treatments:

Explanatory Variable:

Response Variable:

Experiment or Obs. Study:

Example 2: I want to test out a new plant food. So I take 20 plants, and give half the new plant food and half no food at all. All of the plants get the same amount of water and sunlight each day. After 30 days, I measure the height that the plant has grown, and also how many flowers it has on it.

Subjects/Individuals:

Treatments:

Explanatory Variable:

Response Variable:

Experiment or Obs. Study:

Example 3: Effect of AP classes on college acceptances. I get a list of all students in a high school, as well as the number of AP classes each student took over their 4 years of HS. I then obtain the % of colleges they were accepted into. I compare the % acceptance for the students who did not take AP classes to those that did.

Subjects/Individuals:

Treatment:

Explanatory Variable:

Response Variable:

Experiment or Obs. Study:

EXPERIMENTING BADLY

Lurking Variables-

* A variable that has an important effect on the relationship among the variables in a study but is not included in the expt/study *(is not one of the Explanatory Variables)*

Confounded Variables-

* Two variables are said to be confounded when their effects on a response variable cannot be separated from each other. *(there is more than one Explan. Variable and you can't tell which one is affecting the response var.)*

Clinical Trials-

* Experiments that study the effectiveness of medical treatments on actual patients.

Placebo-

* A dummy treatment
    * *Example: sugar pill, "vitamin" water*

Placebo effect-

* When an individual reacts to the placebo
* The reaction can be positive or negative
    * *Example: feeling better because of sugar pill, claiming you are performing better because of "vitamin" water*

DESIGNING EXPERIMENTS!

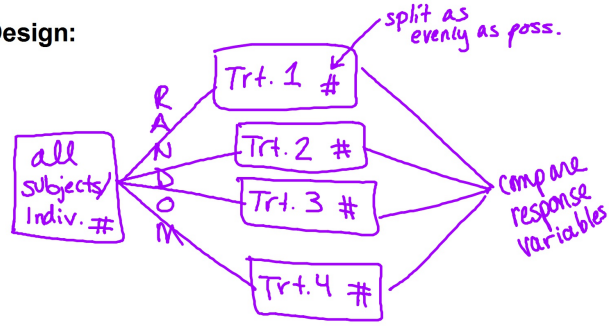
Let's go back to the plant food example from before.

I want to test out a new plant food. So I take 20 plants, and give half the new plant food and half no food at all. All of the plants get the same amount of water and sunlight each day. After 30 days, I measure the height that the plant has grown, and also how many flowers it has on it.

How could we draw the design of this experiment?

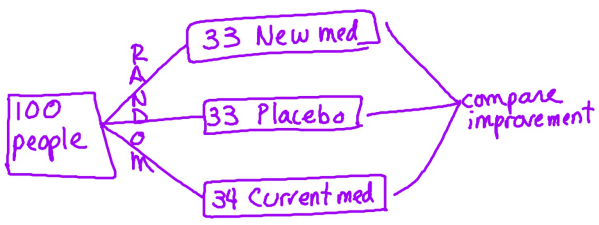
Randomized Comparitive Experiment: (aka Completely Randomized Design) CRD

Design:



Example: ~~plant fertilizer from before~~

100 people. Testing new med vs. placebo vs. current med



Control Group:

A group that receives:

- no treatment
- or a placebo (humans)
- or a current treatment

Used for comparison to the treatment group.

* When you have subjects (people), try to include a placebo as the control group.

Ex: AIDS patients

Example 1:

High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company developed a new cholesterol-reducing drug. Researchers would like to compare the effects of the new drug with the currently used and accepted drug. 100 Volunteers who have a history of high cholesterol and who are currently not on any medication will be recruited to participate.

What are the treatments?

new chol. drug vs. current chol. drug

What are the subjects/individuals?

100 volunteers w/ high chol.

What is the response variable?

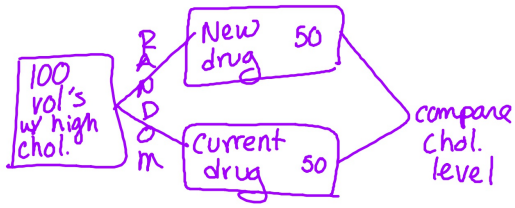
cholesterol level

Would a placebo group be appropriate/necessary?

yes - currently not on a drug

no - not sure why on no meds

Design the experiment:



Example 2:

A biologist is interested in studying the effects of both growth-enhancing nutrients and different salt levels on the growth of shrimps. The biologist is planning on using 3 different growth-enhancing nutrients (A, B, C) combined with 2 different salt levels (high and low). There are 12 tanks of shrimp available to give the treatments to.

What are the treatments? High A, High B, High C, Low A, Low B, Low C, No trt.

What are the subjects/individuals?

shrimp - 12 tanks

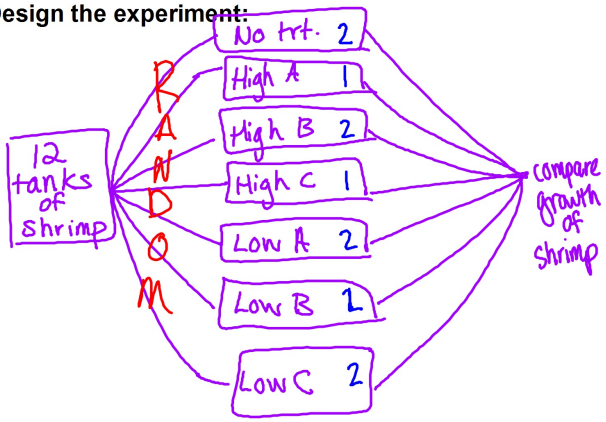
What is the response variable?

growth of shrimp

Would a control/placebo group be appropriate/necessary?

No trt.

Design the experiment:



Example 3:

As dogs age, they have diminished joint and hip health that may lead to pain and reduce a dog's activity level. This reduction in activity can also lead to other conditions such as weight gain and lethargy. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health. Researchers will randomly select 300 dogs from different large veterinary clinics around the county to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

What are the treatments?

What are the subjects/individuals?

What is the response variable?

What would be the advantage of adding a control group to this study?

Design the experiment below (including your control group)

Example 3: As dogs age, what they have diminished joint and hip health that may lead to pair and reduce a dog's activity level. This reduction in activity can also lead to other conditions such as weight gain and lethargy. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health. Researchers will randomly select 300 dogs from different large veterinary clinics around the county to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

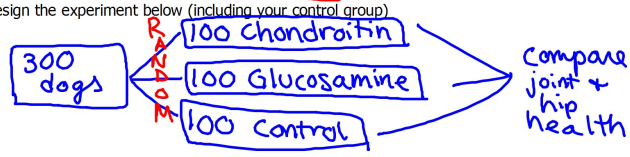
What are the treatments? Chondroitin and Glucosamine & Control

What are the subjects/individuals? Individuals = 300 Dogs

What is the response variable? joint and hip health

What would be the advantage of adding a control group to this study? we could see how the dogs joint and hip health is naturally, and compare that to how it is on the meds

Design the experiment below (including your control group)



Example 4: The dentists at a dental clinic would like to determine if there is a difference between the number of new cavities in people who eat an apple a day and in people who eat less than one apple a week. They are going to conduct a study with 50 people in each group.

50 clinic patients who report that they routinely eat an apple a day and 50 clinic patients who report that they eat less than one apple a week will be identified. The dentists will examine the patients and their records to determine the number of new cavities the patients have had over the past two years. They will then compare the number of new cavities in the two groups.

- Why is this an observational study and not an experiment? no trt. given to patients
- What lurking variables are there in the design of this study? teeth brushing, other foods, genetics, toothpast age, floss
- Explain the concept of confounding in the context of this study.

Use your lurking variables from above to help

Example 4:

The dentists at a dental clinic would like to determine if there is a difference between the number of new cavities in people who eat an apple a day and in people who eat less than one apple a week. They are going to conduct a study with 50 people in each group.

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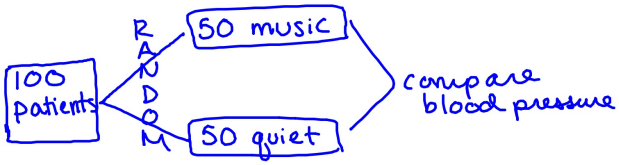
1) Why is this an observational study and not an experiment? There is no treatment. The patients say that they do or do not eat apples each day.

2) What lurking variables are there in the design of this study? other foods that they eat, brushing teeth and flossing, dental care, etc.

3) Explain the concept of confounding in the context of this study. Use your lurking variables from above to help. Confounding is when we cannot separate the effects of the apples from the other lurking variables above. We cannot separate how much of the cavities is due to the apples and how much is due to teeth brushing, or other foods, or dental care, etc.

Example 5: A researcher wants to conduct a study to test whether listening to soothing music for 20 minutes helps to reduce blood pressure in patients with high blood pressure, compared to simply sitting quietly in a noise-free environment for 20 mins. 100 patients with high blood pressure at a large medical clinic are available for the study. **Design this experiment. Discuss possible sources of bias and lurking variables.**

Example 5: A researcher wants to conduct a study to test whether listening to soothing music for 20 minutes helps to reduce blood pressure in patients with high blood pressure, compared to simply sitting quietly in a noise-free environment for 20 mins. 100 patients with high blood pressure at a large medical clinic are available for the study. **Design this experiment. Discuss possible sources of bias and lurking variables.**



PRINCIPLES OF EXPERIMENTAL DESIGN:

1) CONTROL-
The effects of lurking variables on the response. Try to ensure that the only difference between the groups is the treatments.

2) RANDOMIZATION-
Use randomization to assign individuals to treatments. Reduces bias. (SRS)

3) REPLICATION-
Replication experiment many times and on many individuals from the population. Reduces the chance variation in the results.

Statistically Significant-
- An observed effect so large that it would rarely occur by chance

- Seeing similar results over and over again = significant results!

- Can be from a large sample size or from repeating the experiment a lot

BOOK PROBLEMS (HW)

p. 261 #1, 2, 4, 6

AND

p. 266 #7, 9, 10